


Procédure

	GLAST LAT CAL Mechanical Structure	Ref : GLAST-LLR-PR-016
		Issue : draft
		Date : 02/07/2002
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LAT-DS-00973-01 Composite Fabrication Procedure Calorimeter Structure Engineering Model (EM)		


"As Run" Procedure

Start Date:	Completion Date:
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Change History log

draft	2/07/02	Création	LLR team	P. Poilleux	P. Dupont	O. Ferreira
Ind.	Date	Modifications	Prepared	Checked	PA Approval	Project Approval

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AS-RUN SUMMARY

IDENTIFICATION						
Equipment:			Model:		Job Number:	
OPERATORS						
The operators mentioned below are certified to properly execute of this As-Run Procedure in agreement with its contents						
Name			Function		Date	Signature
OPEN TASKS						
Test	Phase	Stage	Comments			Enclose
NON CONFORMITY						
Test	Phase	Stage	Specification	Result	FA n°	FA Title



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List of Acronyms

AIT	Assembly, Integration and Test
AFEE	Analog Front-End Electronics
CAL	Calorimeter Subsystem of the Large Area Telescope (LAT)
CDE	Crystal-Diode Element
CEA	Commissariat à l'Energie Atomique
CNES	Centre National d'Etudes Spatiales
DCI / ICD	Dossier de Contrôle des Interfaces / Interface Control Document
DCF	Dossier de Fabrication et de Contrôle (Control and Shop Files)
DD	Dossier de Définition (Definition Files)
DJD	Dossier Justificatif de la Définition (Justification File for the Definition)
EM	Engineering Model
EMC	Electromagnetic Compatibility
EGSE	Electric Ground Support Equipment
GLAST	Gamma-Ray Large Area Telescope
LAT	Large Area Telescope
LLR	Laboratoire Leprince-Ringuet
LPNHE	Laboratoire de Physique Nucléaire des Hautes Energies
N/A	Not Applicable
NRL	Naval Research Laboratory
PCB	Printed Circuit Board
SLAC	Stanford Linear Accelerator Center
STB	Spécification Technique de Besoin (Technical Specification of Need)
TBR	To Be Resolved
TBD	To Be Defined
TBC	To Be Confirmed
AD / RD	Applicable / Reference Documents
ADP	Acceptance Data Package
CIDL	Configuration Items Data List
EM	Engineering Model

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FM	Flight Model
GSE	Ground Support Equipment
H/W	Hardware
DML / DPL	Declared Material / Process List
DRB	Delivery Review Board
MRB	Mechanical Review Board
FA	Fiche d'Anomalie (Anomaly Card)
PDR / CDR	Preliminary Design Review / Critical Design Review
PCI	Plaque composite inférieure (Lower Composite Plate)
PSI	Plaque composite supérieure (Upper Composite Plate)
Esx	Upper Stacking n°x
Eix	Lower Stacking n°x
Elx	Side Stacking n°x

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1. **OBJECT**

This procedure describes the manufacture of the composite part of the mechanical structure of the calorimeter. It takes into account the modifications raised during integration of the VM2 model.

This unit is made up:

- of a carbon composite structure, which houses 96 CsI crystals
- titanium inserts planned for the fixing of the reinforcement.

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2. DOCUMENTATION


2.1 APPLICABLE DOCUMENTS

The documents below are necessary for the completion of the activities:

<i>Title</i>	<i>Reference</i>	<i>Iss</i>	<i>DATE</i>
AP01 Assembly Drawings			
AP02			
AP03			
AP04			

2.2 REFERENCE DOCUMENTS

<i>Title</i>	<i>Reference</i>	<i>Iss</i>	<i>DATE</i>
RD01 Composite CAL Structure Lay-Up Procedure	LAT-PS-00777-01	Draft	23/04/2002
RD02			
RD03			
RD04			

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3. ENVIRONMENT

3.1 PERSONNEL

All of the tasks will be carried out by qualified personnel.

The team will be at least made up of:

- 1 person in charge of the activity,
- 1 qualified technician,
- 1 representative from Quality Assurance.

3.2 PARTICULAR PRECAUTIONS


- All of the stages must be carried out in a clean room under controlled hygroscoy and temperature.
- The pre-preg material is stored in a freezer. (T°C?)
- Handling will be done using gloves.
- The use of masks is obligatory during the use of unmoulding.
- Any variation compared to this procedure will be subjected to the agreement of the Quality Assurance person in charge.

3.3 CONSUMABLE MATERIALS

The consumable hardware hereafter is necessary to carry out the activities.

(*): The operators will verify that these products are equipped with a certificate of validity in command so necessary.

- Unpowdered Latex Protective Gloves
- Protective Masks
- Gowns
- Teflon Tape
- Markers
- Sponge
- Acetone
- Isopropanol
- Unmoulding (*)
- Sheets of Expanded Foam

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3.4 FACILITES

The integration of the equipment will be carried out in the grey room located at Laboratoire Leprince Ringuet de l'école Polytechnique.

3.5 CLIMATIC ENVIRONMENT AND CLEANLINESS

The integration area will be maintained under the following conditions:


- Temperature : $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- Relative Humidity: $< 60\%$
- Cleanliness: Clean Room

These conditions will be controlled regularly by the Quality Assurance person in charge.

3.6 TOOLS

The following tools are necessary to carry out the activities:

- Tool Box
- Aluminum Mold (1 base plate, 1 top plate, 8 frameworks)
- 8 Pressing Bars
- 16 U Parts
- 96 Aluminum Mandrels
- 192 Mandrel End Pieces
- 16 Bars for positioning carbon fiber pre-preg material for the side inserts
- 2 Plates for positioning carbon fiber pre-preg material:
 - for the lower inserts (PCI)
 - for the upper inserts (PCS)
- Positioning Pins
- Extractors for the bars for positioning carbon fiber pre-preg material and for the ends

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4. DATA PROCESSING

4.1 ANOMALIES

Any anomaly detected by the team will be the subject to an anomaly card.

4.2 RECORDING OF THE FOLLOW-UP OF MANUFACTURE


All the data collected during the test and integration activities will be recorded and will include :

- update of the Log Book through cards of tasks & operations,
- photographs,
- Anomaly Cards.
- *monitoring sheest of the hardware*

4.3 FABRICATION REPORT

A Fabrication Report will be written at the completion of the fabrication process.

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5. PROCEDURE

The various phases of preparation and manufacture are detailed in the following pages.

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Description of the Activity:			
Num. Oper.	Description of the Operation	Procedure/Réf. breaks into leaf résult. or comments	Sign. & Date
0	PREPARATION		
	<ul style="list-style-type: none"> Verify the presence of the documents mentioned in section 2.2. Verify the presence of the materials mentioned in section 3.3. Vérifier que les composants sont munis de leur certificat de conformité. 	section 2.2 section 3.3	
1	VERIFICATION OF THE INSERTS		
2.1	<ul style="list-style-type: none"> Test the screw pitches of each insert with the counterparts 		
2.2	<ul style="list-style-type: none"> Separately identify and store the inserts for each level: <ul style="list-style-type: none"> 25 Bottom Inserts (M5, Interior Threads) 16 Top Inserts (M4, Interior Threads) 40 Side (M6, Exterior Threads and M2.5 Interior Threads) 		
2	CLEANING AND PREPARATION OF THE MOLD TOOLS (GREY ROOM)		
2.1	<ul style="list-style-type: none"> Clean all of the metal parts in an acetone bath 		
2.2	<ul style="list-style-type: none"> Clean all of the metal parts in an isopropanol bath 		
2.3	<ul style="list-style-type: none"> Clean the nonmetal parts (composite) with alcohol? 		
2.3	<ul style="list-style-type: none"> Control the temperature and the humidity of the grey room Re-enter the parts in the grey room 		



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2.4	<ul style="list-style-type: none">• Pass from unmoulding on all of the parts• Let dry for ½ hr• Repeat the operation once and to let dry 1/2h again Note: surface should not let appear of lack of product		
3	ASSEMBLY OF LEVEL 0 (CLEAN ROOM)		

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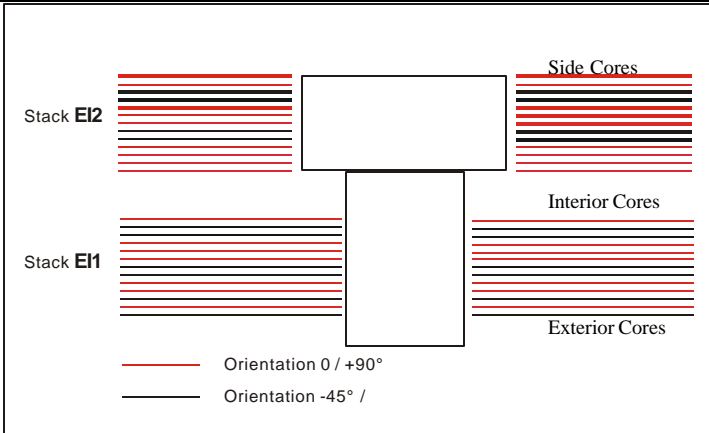
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Description of the Activity:

Num. Oper.	Description of the Operation	Procedure/Réf. breaks into leaf résult. or comments	Sign. & Date
3.1	 <ul style="list-style-type: none"> Remove the protective sheet from the "interior side" of EI2 Adjust the base plates of the 25 inserts (050305) in the holes of stack EI2 so that the cylindrical part remains within the interior dimensions Remove the protective sheet from the "interior side" of EI1 Cover the stack EI1 by taking care to make the faces coincide "with the interior dimensions" as well as the reference axes X and Y Remove the protective sheet from the "external side" of EI1 Position the Teflon rings on each insert Position lower composite plate NCV on the unit Pre-form pre-preg material around the inserts 		
3.2	<ul style="list-style-type: none"> Lay out this unit on level 0 using the positioning pins of the composite plate 		



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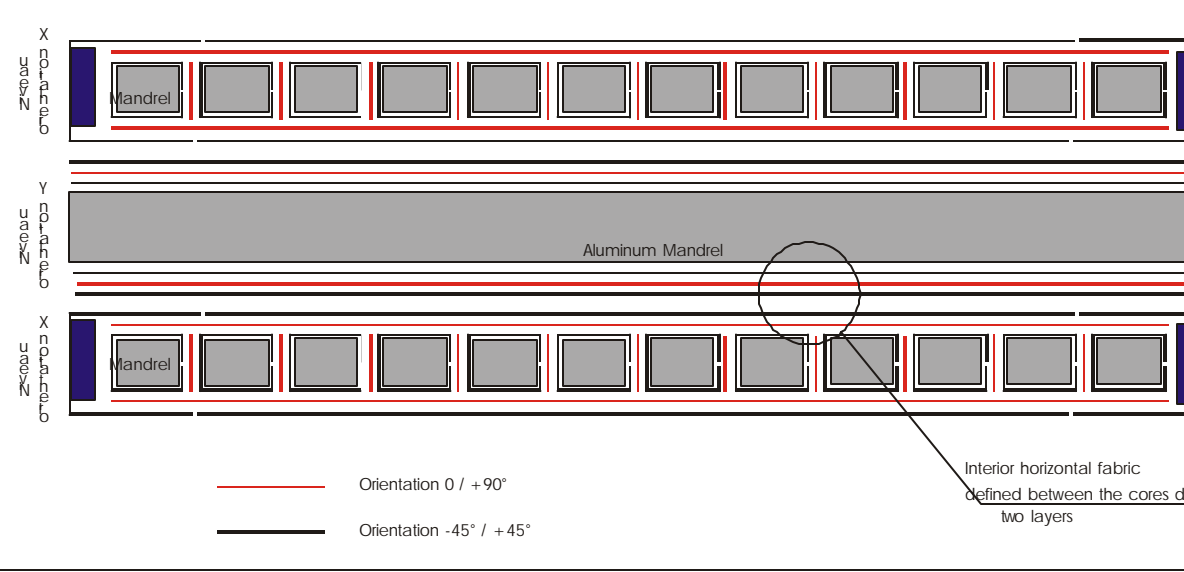
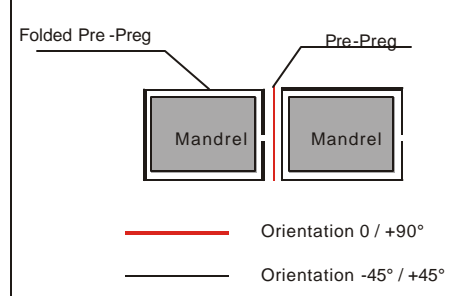
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Description of the Activity:

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4	<p>ASSEMBLY OF LEVEL 1 (CLEAN ROOM)</p>  <p> — Orientation 0 / +90° — Orientation -45° / +45° </p>		



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4.1	<p>Winding of the Cores</p> <ul style="list-style-type: none"> • · Oter protection interior side of a "fold coating cores" • Wind the first core with 1 fold on a foam sheet • · not to make recovery but to have the quite jointed edges • · to direct Well the fold compared to the axis of the core in order to respect the orientation of fibres • Verify that the fabric arrives at more close to the setbacks at the two ends of the cores • Remove part of protection "side external" of the fold of the core with the level of the connection • Remove the protection on a side of the "inserted fold cores" • Cover the face with connection with the "inserted fold cores" • Remove the 2nd protection of the "inserted fold cores" • Place the core wound in the framework (n°9) with the face of connection towards the interior • Repeat the operation for cores 2 to 11, while placing each bar against the preceeding bar. • Repeat the operation for core 12, but not to put a "inserted fold cores" 	To define	



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4.2	<p>Assembly of all of the cores</p> <ul style="list-style-type: none"> • Tighten all of the cores using the pressing bar • Assemble them by adding an "interior horizontal fold" • <i>Pass a roller on the fold to smooth the unit</i> • Turn over the block (cores + tallies) • Cover the 2nd face by a "interior horizontal fold" • <i>Pass a roller on the fold</i> • Turn over the block (cores + tallies) 	The roller takes off protection	



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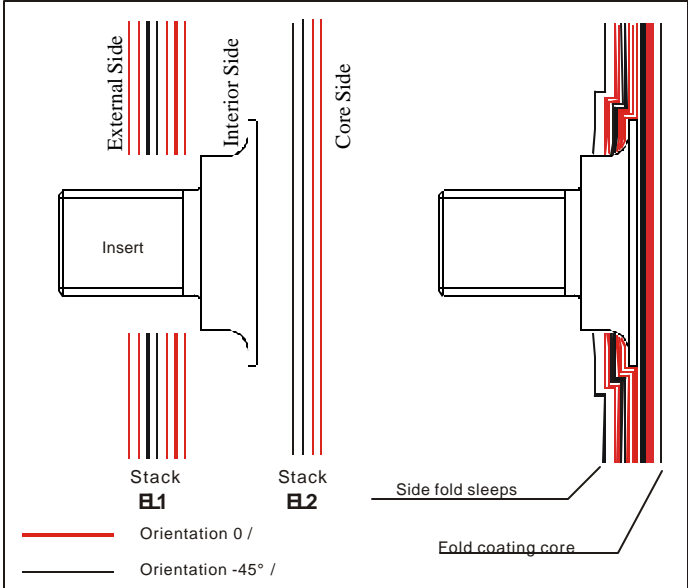
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4.3	<p>Side reinforcements level 1 (2 inserts)</p> 		
4.3.1	<p>Preparation of the bars for positioning of the inserts:</p> <ul style="list-style-type: none"> • Cut out the Teflon tape discs with an internal diameter equal to the diameter external of the inserts • Position the tape discs on the bars for positioning of the inserts (2 holes) 		



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4.3.2	Preparation of the Reinforcement: <ul style="list-style-type: none"> • Withdraw plastic protective film "with dimensions interior" from the stack EL1 • To parallel to install the 2 side inserts by directing with dimensions square base plate cutting and so that the cylindrical part brings out "external side" • Integrate the bar for positioning of 2 holes • Oter protection "interior side" of EL2 • Cover the stack EL2 by taking care to make coincide faces "with dimensions interior" of EL1 and EL2 as well as the reference axes X and Y • Pre-form the pre-preg around the base plate and cut out the surplus material • Withdraw the stack of the bar of positioning using the extractors 		
4.3.3	Addition of the "side fold sleeps" <ul style="list-style-type: none"> • Oter protection "side external" of EL1 • Remove the medium (height of a layer) of the protection of the "side fold lays down" "interior side" • Apply it to the external side of EL1 following the inserts • Remove the medium (height of a layer) of the protection of the "side fold lays down" "external side" • Position the whole on one of the bars of positioning (2 holes) prepared into 5.3.1 		
4.3.4	<ul style="list-style-type: none"> • Repeat the operation for the second reinforcement 		



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4.3.5	<p>Assembly of the side reinforcement on the block of cores</p> <ul style="list-style-type: none"> Assemble the whole on the block (wound cores + lower and higher horizontal folds) by taking care to position the reductions of the "side fold well sleeps" Compress the whole Remove the protective sheets of the reductions and to apply them to the block Remove the protective sheets of the "external folds lays down" "interior side" Apply them to the block by making a recovery on each side for the connections "side fold sleeps/external folds sleep" Cut out in the medium using a cutter in order to obtain jointed edges Pass the roller to smooth the unit 		
4.3.6	<ul style="list-style-type: none"> Repeat the operation for the other side of the block 		
4.5	<p>Installation of the ends</p> <ul style="list-style-type: none"> Set up the ends at each end of the cores while avoid gripping the fabric Use dissymmetrical ends for the external cores 1 and 12, to put the broader side towards outside (towards the framework) 		
4.6	<ul style="list-style-type: none"> Make slip the ends of the layer into U by respecting the position of U fixed and U mobile Place all within the framework level 1 (higher part of the framework upwards) Fix U using the adequate screws Place the pressing bar within the framework Tighten the screws on U mobile until putting in contact the ends of the cores and U fixed Tighten the screws of the pressing bar by gradually distributing the exerted force Check with a foil to verify that the contact is well established 		



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4.7	<ul style="list-style-type: none"> • Oter the sheet of lower protection external of the level 1 and that of level 0 • Come to position level 1 on level 0 using the positioning pins in order to align the reference marks (on the level of an angle) 		
5	ASSEMBLY OF LEVEL 2 (CLEAN ROOM)		
5.1	<ul style="list-style-type: none"> • Proceed as for level 1 except for the side reinforcements because there are 3 inserts on each side on this level • Oter the sheet of higher protection of the level 1 and that lower of level 2 • Position the framework of level 2 compared to level 1 in order to align the reference marks 		
6	ASSEMBLY OF LEVEL 3 A 8 (CLEAN ROOM)		
6.1	<ul style="list-style-type: none"> • Procedure as for level 1 • Take into account the difference of the number of side inserts for each level (figure annexes X: Provision of the layers of the composite structure) • Oter the sheet of higher protection of the level X and that lower of the X+1 level • Position the framework of the X+1 level compared to level X in order to align the reference marks 		
7	ASSEMBLY OF LEVEL 9 AND CLOSING OF THE TOOLS (CLEAN ROOM)		



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7.1	<p>Top Reinforcement:</p> <ul style="list-style-type: none"> • Withdraw protection "interior side" of ES2 • Adjust the base plates of the 16 inserts (050304) in the holes of stacking ES2 so that the cylindrical part remains "with dimensions interior" • Withdraw the sheet of protection "interior side" of ES1 • Cover with stacking ES1, taking care to make faces coincide "with dimensions interior" as well as the reference axes X and Y • Oter protection "side external" of ES1 • Position the Teflon rings on each insert • Position top composite plate GCV on the unit • Pre-form the pre-preg around the inserts 		



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7.2	<ul style="list-style-type: none"> To lay out this unit on level 9 using the pawns of positioning of the composite plate Visser, side external of the mould, plate GCV on the framework of level 9 for its maintenance 		
7.3	<ul style="list-style-type: none"> To remove protection "side core" of ES2 and that higher of level 8 To come to superimpose level 9 on level 8 using the pawns of positioning in order to align the reference marks To close the whole of the mould with the screws envisaged for this purpose (attention with screwing well the threaded rods on level 0 before tightening the nuts of level 9) 		
7	CURING		
7.1	To set up of the structure in the drying oven using Fenwick		
7.2	<p>Programming of the furnace: (cycle in appendix)</p> <p>To use the program n°3 drying oven (program in appendix)</p> <p>1/ To increase the temperature of 4°C/min until 250°C (valve of distribution closed)</p> <p>2/ To make a stage of 90 min with 250°C (valve of distribution closed)</p> <p>3/ At the end of this stage to position the handle of the valve enters reference marks 1 and 2</p> <p>4/ To regulate the temperature of the drying oven with 135°C (descent + stage)</p> <p>5/ After 180 min to cut the heating, to leave distribution</p> <p>6/ To let cool the drying oven until 60°C</p> <p>7/ To open the gate and to let cool the mould at ambient temperature</p> <p>8/ To leave the structure of the furnace and to re-enter it in the gray room</p>		
8	REMOVAL FROM MOLD (GRAY ROOM) AND CLEANING		



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8.1	<ul style="list-style-type: none"> Loosen the side screws of the pressing bars and U mobiles Remove the screw of plate GCV Loosen and withdraw the threaded rods Oter the higher plate of level 9 Remove the Teflon rings by screwing the threaded part of the ring Oter the composite plate for positioning of the inserts 		
8.2	<ul style="list-style-type: none"> Unscrew and remove the pressing bar of level 8 Disassembly the framework of U Remove the positioning pins Remove the framework · Oter U Remove positioning bars in composite to the right of the inserts using the extractors Remove the ends of the cores Remove the cores from the cured cells, pushing them by hand 		
8.3	<ul style="list-style-type: none"> Repeat operations of Step 8.2 for the 7 other rows 		
8.4	<ul style="list-style-type: none"> Remove the structure of level 0 Remove the Teflon rings by screwing the threaded part of the ring of lower plate NCV Oter the composite plate of positioning of the inserts Remove the resin burrs from the cured structure 		
8.5	<ul style="list-style-type: none"> Clean all of the tools in a bath of acetone followed by a bath of isopropanol 		



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APPENDICES

A. Stacking of the Lower Layers

EI 1

External Dimensions

Pli 1	-45°/+45°
Pli 2	0/+90
Pli 3	-45°/+45°
Pli 4	0/+90°
Pli 5	0/+90°
Pli 6	-45°/+45°
Pli 7	-45°/+45°
Pli 8	0/+90°
Pli 9	0/+90°
Pli 10	0/+90°
Pli 11	-45°/+45°
Pli 12	-45°/+45°
Pli 13	0/+90°

Internal Dimensions

EI 2

Internal Dimensions

Pli 14	0/+90°
Pli 15	0/+90°
Pli 16	0/+90°
Pli 17	-0/+90°
Pli 18	-45°/+45°
Pli 19	-45°/+45°
Pli 20	0/+90°
Pli 21	0/+90°
Pli 22	0/+90°
Pli 23	-45°/+45°
Pli 24	-45°/+45°
Pli 25	0/+90°
Pli 26	0/+90°

Core Dimensions



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B. Stacking of the Upper Layers

ES1

External Dimensions

Pli 1	-45°/+45°
Pli 2	0/+90°
Pli 3	-45°/+45°
Pli 4	-45°/+45°
Pli 5	0/+90°
Pli 6	0/+90°


Internal Dimensions

ES2

Internal Dimensions

Pli 7	-45°/+45°
Pli 8	0/+90°
Pli 9	0/+90°
Pli 10	-45°/+45°
Pli 11	0/+90°
Pli 12	0/+90°
Pli 13	-45°/+45°

Core Dimensions

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C. Stacking of the Side Reinforcements

EL1

External Dimensions

Pli 1	0/+90°
Pli 2	0/+90°
Pli 3	-45°/+45°
Pli 4	-45°/+45°
Pli 5	0/+90°
Pli 6	0/+90°
Pli 7	0/+90°

Internal Dimensions

EL2

Internal Dimensions

Pli 8	-45°/+45°
Pli 9	-45°/+45°
Pli 10	0/+90°
Pli 11	0/+90°

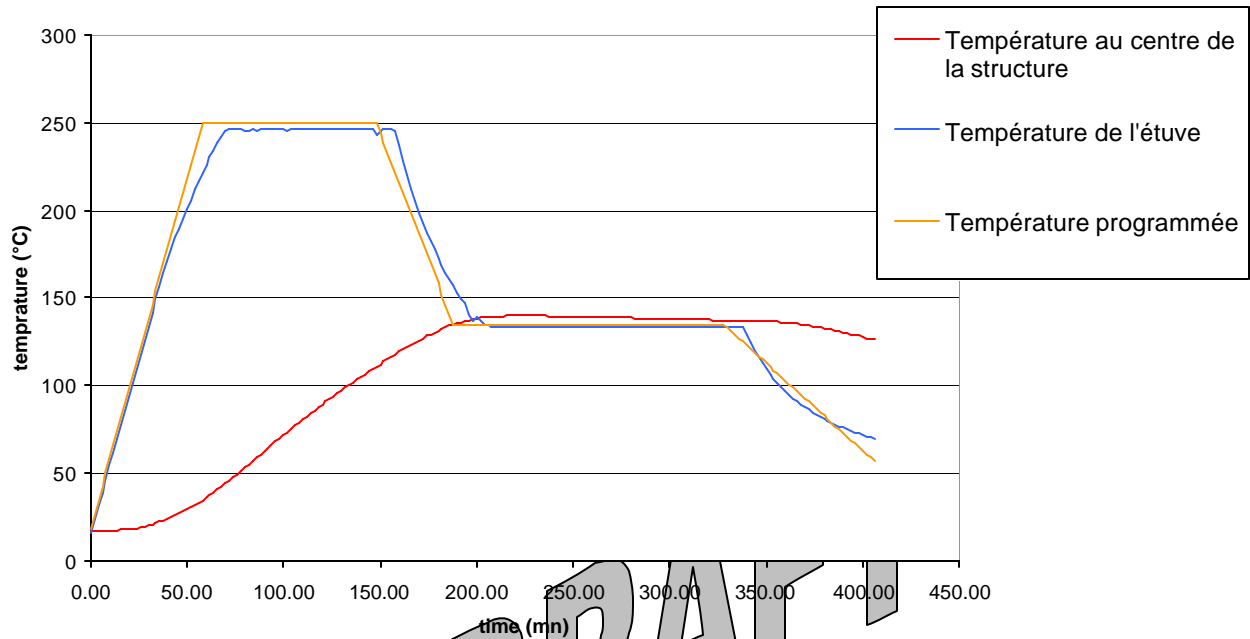
Core Dimensions




**Composite Fabrication
Procedure
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D. Cycle Temperature for the Polymerization of the Pre-Preg Material



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E. Program n° 3

Prog	list	
Prg.n	3	N° Program
Hb.v	5°	value maintenance on variation reading, instruction
RmP.u	mn	unit of slope
DwL.u	mn	unit of stage
Cyc.n	1	number of cycles
SEG.n	1	N° segment
Type	rmPr	slope at a given speed
Hb	lo	type of maintenance on variation
TGt	250°	consign
Rate	4°/mn	speed of slope
Out.1	on	ventilation
Out.2	on	heating
Out.3 à 8	off	
SEG.n	2	N° segment
Type	dwELL	stage during time given
Hb	Lo	maintenance on variation of low deviation
dur	90 mn	consign
Out.1	on	ventilation
Out.2	on	heating
Out.3 à 8	off	
SEG.n	3	N° segment
Type	step	jump
Hb	off	maintenance on decontaminated variation
tGT	135°	consign
Out.1	on	ventilation
Out.2	off	heating
Out.3 à 8	off	
SEG.n	4	N° segment
Type	dwELL	stage during time given
Hb	Lo	maintenance on variation of low deviation
dur	180 mn	consign
Out.1	on	ventilation
Out.2	on	heating
Out.3 à 8	off	
SEG.n	5	N° segment
Type	step	jump
Hb	off	maintenance on decontaminated variation
tGT	25°	consign
Out.1	on	ventilation
Out.2	off	heating
Out.3 à 8	off	
SEG.n	6	N° segment
Type	dwELL	stage during time given
Hb	off	maintenance on decontaminated variation
dur	600 mn	consign
Out.1	on	ventilation
Out.2	off	heating
Out.3 à 8	off	
SEG.n	7	N° segment

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Type
Out.1 à 8

end
off

DRAFT